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Moving from adequate to optimal drinking water quality. A reassessment of mineral composition

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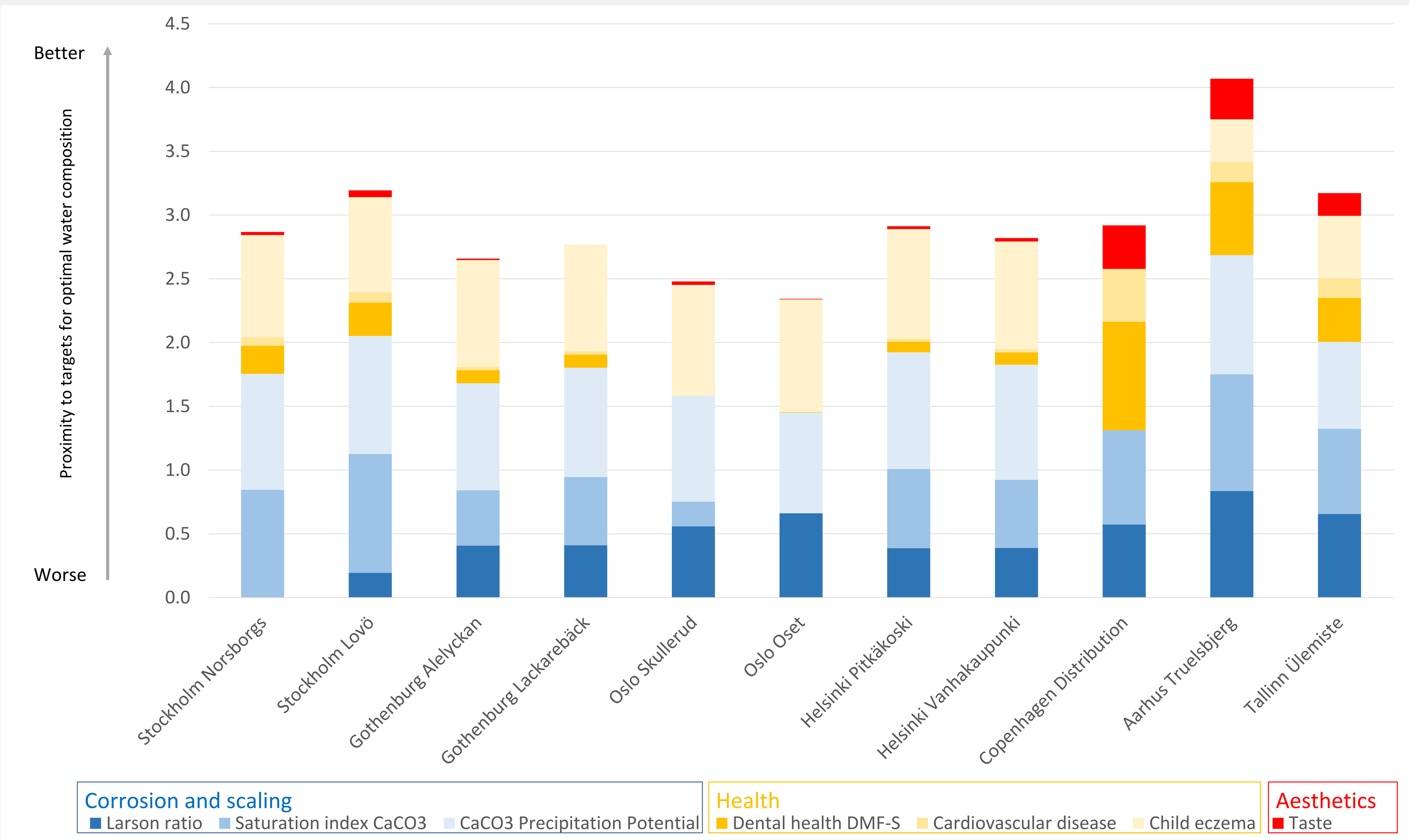
Drinking water guidelines are designed to ensure the safety of the public against microbial or chemical hazards from drinking water. But there a several more subtle effects from drinking water quality. I propose a set of indicators for drinking water quality assessment that allows for a ranking of its quality in terms of health impacts, aesthetics and corrosion potentials

Method

Each indicator has been defined by a target composition considered optimal for a specific impact. For example, compositions leading to a Calcium Carbonate Precipitation Potential of 5 mg/L were considered optimal for scaling control. Similarly, a composition high in fluoride and calcium, but within recommended guidelines, would be the target for dental health protection. The potential impacts are reported as a normalized distance-to-target-value ranging from zero to one. A value of one indicates that the composition equals the target value, while a value of zero indicates the largest distance-to-target out of the surveyed water compositions. As such, the normalized values indicate the relative position for each surveyed water quality, compared to the other water qualities in question. Until now seven impact categories have been assessed for 11 Nordic water supply systems: corrosion potential towards iron (Larson Ratio), Saturation index and precipitation potential for $CaCO_3$, dental health (DMF-S), cardiovascular disease (magnesium content), child eczema (total hardness), and taste (preferred ions vs unwanted ions).



Assessment of drinking water quality for 11 Nordic water supply systems. Results are based on latest published water quality reports as of December 2017.

Indicators with perceived optimal values (target values). The list is based on a literature review. *[Ca]+[Mg]+[HCO_3]+[SO_4]-[Cl]-[K]-[Na] expressed in mmole/L maximum allowable limit.

Indicator	Target	Explanation
Larson ratio	0	$\frac{[Cl]+2[SO_4]}{[HCO_3]}$ is indicative of corrosion of iron and possibly steel. Lower is better.
Saturation index $CaCO_3$	0.2	$log\left(\frac{[Ca][CO_3]}{K_s}\right)$ indicates saturation state. Slight oversaturation is preferred.
Calcium Carbonate Precipitation Potential (CCPP)	5	Amount of $CaCO_3$ precipitated or dissolved to achieve equilibrium in a closed system (mg/L as $CaCO_3$). Calculated by PHREEQC and slight oversaturation is preferred.
Dental health DMF-S	1.8	Predicted number of Decayed, Missing, or Filled Surfaces (DMF-S). <1.8 is assumed very low incidence by WHO.
Cardiovascular disease	50	EU max guideline for magnesium (mg/L). Higher is better.
Child eczema	0	Water hardness (mg/L as $CaCO_3$). Lower is better.
Taste	18	Sum of EU max guidelines for minerals contributing to taste perception (mmole/L)*.

Conclusion

Drinking water quality guidelines aim to ensure an adequate rather than optimal water quality. The results reveal the variance of perceived water quality across water supplies that all adhere to current guidelines. Further work will seek to validate the proposed indicators and add indicators for more effects.

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